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Abstract

This paper addresses the following questions. Is there evidence of financial contagion in the Eurozone? To what extent a country's vulnerability to contagion depends on "fundamentals" as opposed the government's "credibility"? We look at the empirical evidence on European sovereigns CDS spreads and estimate an econometric model where a crucial role is played by time varying parameters. We model CDS spread changes at country level as reflecting three different factors: a Global sovereign risk factor, a European sovereign risk factor and a Financial intermediaries risk factor. Our main findings are as follows. First, Unlike the US subprime crisis which affected all European sovereign risks, the Greek crisis is largely a matter concerning the Euro Zone. Second, differences in vulnerability to contagion within the Eurozone are even more remarkable: the core Eurozone members become *less* vulnerable to EUZ contagion, possibly due to a safe-heaven effect, while peripheric countries become more vulnerable. Finally, market fundamentals go a long way in explaining these differences: they jointly explain between 54 and 80% of the cross-country variation in idiosyncratic risks and in the vulnerability to contagion, largely supporting the "wake-up call" hypothesis according to which market participants become more wary of market fundamentals during financial crises.

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1 Introduction

Even before the Euro began to circulate in 2002, it achieved a remarkable compression of interest differentials in the Eurozone. The sudden elimination of exchange risks and the following convergence of government bond yields lead to huge windful interest savings for high debt countries. Between 2000 and 2005 the interest spread between Greek and German bonds effectively vanished, reaching a minimum of 18 basis points; similarly, interest payments in Italy collapsed from almost 12% of GDP in 1996 to less than 5% in 2006. With the benefit of hindsight, these gains were largely dissipated as the European institutional safeguards that should have insured fiscal discipline (the Stability and Growth Pact) proved ineffective. Yet, for more than a decade financial markets failed to impose any discipline, pricing higher premia for governments pursuing unsound fiscal policies and/or countries running unsustainable current account deficits. It was only after the collapse of Lehman Brothers in September 2008, and most notably with the onset of the Greek sovereign debt crisis in late 2009, that markets realized that the Euzone membership did not imply a full guarantee against insolvency, and that permanence in the Euro area could not to be taken for granted for many highly indebted countries.

The Greek crisis erupted in late 2009 when the neo-elected government of George Papandreou revised the estimate for the budget deficit-GDP ratio from 7.5 to an alarming 13.5 per cent. Two years later, the EU-IMF-ECB troika agreed with bondholders on a large restructuring of Greek debt which imposed an heavy haircut on the private sector, estimated at 75 percent in present value terms, but failed to reassure markets about Greece's permanence in the Eurozone. Portugal, and Ireland have since lost market access and were bailed out by the troika. Spain has resorted to European Financial Stability Fund (EFSF) in order to recapitalize its banking sector, and Spain (and Italy?) may apply to the European Stability Mechanism (ESM) and/or to the Outright Monetary Transaction intervention of the ECB, in order to curb the rise in interest rates. While government bold yields and CDS spreads were rising sharply in the EU periphery, contagion became the buzzword of the day. In fact, in many peripheral countries, politicians have blamed financial markets for deliberately "attacking" the Eurozone, and their own country in particular.

This paper addresses the following questions. Is there evidence of contagion in the Eurozone? To what extent do sovereign risk and the vulnerability to contagion depend on fundamentals as opposed to a country's "credibility" (e.g. Monti vs Berlusconi)?

There are two sides in this debate. In the literature on speculative attacks, the "fundamentalist" view is associated to the "first generation models" of balance of payment crises stemming from Krugman (1979), where speculative attacks only hasten home the delivery of the bad news: economic fundamentals (monetary financing of the fiscal deficit) are incompatible with fixed exchange rates. Similarly, in the "sudden stops" literature pioneered by Calvo (1998), capital flow reversals due to unsustainable external positions trigger an abrupt current account reversal. More generally, this view suggests that in order to prevent such crise economic policies should directed at correcting structural imbalances with a view to long term growth. On the other side, the "credibility" view is based on the idea of multiple equilibria pioneered by the Diamond and Dybvig's (1983) model of bank runs, and popularized by Obstfeld's (1986) model of "second generation" speculative attacks. If market come to expect a future devaluation, they require higher interest rates to cover depreciation and this makes it optimal for the government to abandon the peg and depreciate to boost the economy, thus fulfilling markets' expectations. In this framework, a front loaded adjustment may enable the goverment to focus market expectations on the "good" equilibrium of low interest rates and sustainble currency peg. In other models market fundamentals and sunspots interact to generate multiple equilibria (see Alesina, Prati and Tabellini, 1989). On the theory side, Morris and Shin in a series of contributions, see for example Morris and Shin 1998, show that when agents information sets differ slightly, and each individual receives an idiosyncratic signal on market fundamentals, multiple equilibra collapse to a unique equilibrium, which is ultimately determined by market fundamentals: In the empirical literature, Goldstein's (1998) introduced the idea of "wake up call": a crisis in one country makes investors suddenly aware of existing problems elsewhere, an example being the role of Thailand in focusing investors' attention on unsustainable current account positions in other East Asian countries.

This paper tries to shed some light on these issues by looking at the empirical evidence on EU sovereigns CDS spreads. We estimate an econometric model, building on Bekaert et al. (2009), where the crucial role is played by time varying parameters. We model CDS spread changes at country level as reflecting three different factors: a Global sovereign risk factor, a European sovereign risk factor and a Financial intermediaries risk factor. Our main findings are as follows. First, while the US subprime crisis affects all European sovereign risks, albeit with different magnitudes due to the role of financial institutions in each country (Ireland, Austria and the UK being the most affected), the Greek crisis is largely a matter concerning the Euro Zone. Second, differences in vulnerability to contagion in the Eurozone are remarkable: in particular France, Belgium, Italy, Spain, Ireland and Portugal show large and recurrent spikes in idiosyncratic risk. Moreover, after the Greek crisis the core Eurozone members become *less* vulnerable to EUZ contagion, possibly due to a safe-heaven effect, while peripheric countries become more vulnerable.Third, market fundamentals go a long way in explaining these differences. In fact, during crisis time, market fundamentals matter more than during normal times. Variables such as the domestic debt GDP ratio, the growth rate of industrial production and the rate of unemployment which were largely irrelevant before the crisis, become important during the crisis. Also, changes in the country's sovereign rating, which were not statistically significant in normal times, do affect idiosyncratic and contagion risk in crisis time, as markets scramble for "new" information. Market fundamentals jointly explain between 54 and 80% of the cross-country variation in idiosyncratic risks and in the vulnerability to contagion, largely supporting the view that fundamentals matter and that "wake-up calls" are delivered in times of crisis. It then follows that a front loaded, cold-turkey, adjustment which may be desirable for the purpose of improving credibility, may backfire by imposing a heavy "collateral damage" to the economy.

The plan of the paper is as follows. Section 2 discusses the relevant literature on contagion. Section 3 presents the empirical model and our methodology. Here we discuss the data set, as well as the econometric issues involved in the approach. In Section 4 we present the results and discuss their interpretation. Section 5 summarizes and concludes.

2 Review of the literature

The word *contagion* appears in the recent economic debate in the late nineties in the wake of the Mexican and Asian crises. While in the medical science contagion indicates the spread of a disease from one individual to another, in economics contagion has a narrower meaning. Different economies are tied by financial and trade linkages, which are reffered to as spillovers or channels of interdependence; contagion refers to the fact that in particular occasions, typically during "economic crises", the transmission of economic shocks rises in intensity over and above what is justified by "normal" interdependence. In the simplest specification, consider two asset prices y_s in two countries s $=i$, j, that are linked by a relationship of the form:

$$y_i = \beta_{ij} y_j + \varepsilon_i \tag{1}$$

where the interdependence parameter β_{ij} describes the effect of a change in country j's asset price on country i's price. In this framework *contagion* occurs if, during a "crisis" in country j, a structural break occurs in the β_i parameter, which typically rises in absolute value, so that the movement in asset prices in country j is transimitted to country i with an unusual strenght.

Eichengreen Rose Wyplosz (1996) define contagion as the probability that a crisis in a country at a point in time is correlated with the occurrence of a crisis in other countries, after controlling for the effects of political and economic fundamentals. A common approach to testing for contagion is based on the analysis of *correlation coefficients* across asset returns. If the correlation in returns between assets in two markets increases significantly during a crisis, this is interpreted as evidence of contagion. In possibly the first major contribution to the literature, King and Wadhwani (1990) find that the correlation between the U.S, U.K. and Japan increased significantly after the U.S stock market crash ok 1987, see also Lee and Kim (1993), Calvo and Reinhart (1995), Baig and Goldfajn (1999) for an application to Asian and Latin American emerging markets. This approach was criticized by Forbes and Rigobon (1999, 2002), who showed that the rise in asset price volatility during crises may *per se* raise the cross-country *correlation* without determining a change in the *interdependence* parameters β_i of the underlying model (1), see also Boyer, Gibson, and Loretan (1999), as well as Loretan and English (2000). A possible solution consists in adjusting the correlation coefficient for the change in the volatility of returns in the country where the crisis originates, see for example Ronn (1995), Boyer et al. (1999), Loretan and English (2000), Forbes and Rigobon (1999, 2002). The latter authors look at the 1997 East Asian crisis, the 1994 Mexican peso crisis and the 1987 stock market crash in the US. The conventional tests find evidence of contagion in 50 per cent of the cases during the Asian and US episodes, and in about 20 percent of the cases during the Mexican collapse. Conversely, the tests based on the adjusted correlations find almost no evidence.

This result was in turn criticized for example by Corsetti, Pericoli, Sbracia (2005), as it relied on two strong assumptions: i) that contagion spreads from one country to another with the source country being exogenous; ii) that there are no omitted variables which affect both stock markets resulting in spurious correlation. These assumptions bias the test towards rejection of the contagiom hypothesis. For instance, Corsetti et al.consider a factor model where returns in the two countries depend on a common factor. They show that the Forbes and Rigobon 's test is biased towards accepting the null hypothesis of no contagion. Applying their modified test to Hong Kong, Singapore and the Philippines stock markets, they find evidence of contagion, when Forbes and Rigobon test would not, see also Pericoli and Sbracia (2003), Dungey and Martin (2001), Dungey et al. (2005) and Bekaert et al. (2005).

In particular, Bekaert et Ng. (2005) and Bekaert et al. (2011) propose a CAPM approach with time varying factor loadings, which depend on a large set of control variables. Here contagion manifests itself in an increased sensitivity of asset prices to fundamentals at times of crisis. Longstaff and Ang (2011) study the exposure of sovereigns to systemic shocks, in the US and EU. They find that sovereign risk is strongly and negatively correlated with stock market indexes. Bekaert et al. (2011) analize contagion across different portfolios of equity markets of 55 countries during the 2007-09 financial crisis, using a three factor model with a global (US) factor, a financial factor and a domestic factor. Overall, they find only small evidence of systematic contagion from US markets and from the global financial sector to equity markets, but strong evidence of domestic contagion between assets of different sectors in the same country. This latter methodological approach is particularly suitable for our purposes.

Finally, there is a large literature that looks at contagion trough interest rates. For example, Codogno, Favero and Missale (2003) point out that the introduction of a single currency has eliminated real exchange rate risks but, because of the loss of monetary independence, may have potentially increased the risk of default. Many contributions find a common international factor driving interest spreads in the EMU. Dungey et al. (2000) interpret this common factor as a measure of “appetite for risk”, see also Codogno et al. (2003), Favero, Pagano and Von Thadden (2005). Eichengreen and Mody (2000) find evidence of a common international trend for sovereign bond spreads in emerging markets, with US bond yields being the main driver. Subsequent studies have analyzed the determinants of government bond yield spreads in the euro area since 2007. Barrios et al. (2009), using weekly data CDS spreads, find that the impact of domestic factors on bond yield spreads increase signicantly during the crisis, see also Sgherri et Zoli (2009). Recently, Giordano et al (2012) find support for the wake up call hypothesis” looking at bond spreads in the Eurozone.

3 Empirical framework

3.1 The model

Our idea is to model interdependence across European sovereign CDS spreads through a simple three factor model. The theoretical grounding of the model is the arbitrage pricing theory in finance. Asset returns are determined by a set of common factors, representing non-diversifiable risk, and a set of idiosyncratic factors representing diversifiable risk (Sharpe 1964, Solnik 1974, for an appication to the contagion literature see also Dungey and Martin (2001), Corsetti et al. (2001) and Bekaert et al. (2005, 2011)). The model builds on Bekaert et al. (2011) in the use of time varying parameters and in the use of market indexes as a proxy for unobserved sources of commonalities across sovereigns. The "beta" parameters are our measure of the relative responsiveness of a sovereign spread in country i to market movements in country j. The beta embeds the systematic risk of the CDS relative to a reference market and, in parallel with the case of stocks, it can be thought of as a measure of the risk carried by a single entity on a well diversified portfolio of CDS. Note however that these parameters need to be interpreted with caution, since an increase in β_{ij} can result either from an increase in the correlation between the asset prices in country i and j , ϱ_{ij} , or/and from the rise in the relative volatility of country i's spread relative to j, $\beta_{ij} = \rho_{ij}\sigma_i/\sigma_j$.

Relatively to Bekaert et al. (2011) our model differs along several dimensions. First, we apply the analysis to CDS sovereign spreads, rather than to equity markets. Second, given that the number of sovereigns is much smaller than the number of sectors in their analysis, we enlarge the sample space by exploiting the time dimension, rather than sectional dimension. While Bekaert et al. (2011) estimate the model's parameter "before and after" the crisis, and then relate the observed difference to a set of instruments, we develop a different procedure. For all the countries in our sample we estimate the model on a moving window of data. This enables us to recover a long sequence of parameter estimates over time, which we then exploit for testing the determinants of "contagion" effects. Third, we introduce a number of refinements in the construction of market indexes by using principal component analysis in order to have a better proxies for common risk factors. The model looks as follows:

$$\Phi(L)\triangle s_{it} = \alpha_{it} + \beta_{it}^{'}\triangle F_t + \varepsilon_{it} \tag{2}$$

where $\triangle s_{it}$ is the daily change in the CDS spread of country i as of time

t . We assume an autoregressive process so that $\Phi(L)$ is a polynomial in the lag operator L, in order to capture potential autocorrelation in spread changes. F_t is a vector of three different factors, our interdependence channels, measuring Global, European and Financial risks; α_{it} is the drift of the CDS spread daily change of country i at time t, ε_{it} is the residual which we assume to be uncorrelated among countries. We model the parameters of each *i-th* country as follows:

$$\alpha_{i,t} = \alpha_0 + \alpha_1^{'} Z_{i,t-k} + \eta_{i,t} CR_t + \delta EUZ + u_{i,t} \tag{3}$$

$$\beta_{i,t} = \beta_0 + \beta_1^{'} Z_{i,t-k} + \gamma_{i,t} CR_t + \phi EUZ + v_{i,t} \tag{4}$$

$$\eta_{i,t} = \eta_0 + \eta_1^{'} Z_{i,t-k} + \eta_2 EUZ \tag{5}$$

$$\gamma_{i,t} = \gamma_0 + \gamma_1^{'} Z_{i,t-k} + \gamma_2 EUZ \tag{6}$$

where $Z_{i,t-k}$ is a vector of exogenous lagged control variables, primarly macroeconomic fundamentals at country level, which are expected to explain cross country differences in the time varying coefficients, CR_t is a dummy variable that takes value 1 during the period of the Greek sovereign debt crisis and 0 otherwise. $F_t \equiv \left[F_t^G,\ F_t^E,\ F_t^F\right]$ denotes the vector containing the change in a global risk factor, F^G, the change in a European risk factor, F^E and the change in a financial risk factor, F^F (to be discussed below in more detail), and EUZ is a dummy variable that equals one for countries in the Eurozone and zero for countries outside.

Equation (2) is the standard Arbitrage Pricing Theory. Equation (3) captures the idea that the idyosyncratic component of the drift of a country's sovereign spread, α_{it}, may vary through time and may depend on the evolution of a country's macro fundamentals, on whether it's crisis time (contagion effects), on whether the country belongs to the Eurozone. Similarly, equation (4) assumes that the sensitivity parameters β to the different external factors may change over time depending on fundamentals, on the crisis/non crisis periods and on the Eurozone membership . Equations (5) and (6) introduce a new channel through which fundamentals and Euro membership may affect spreads: the state of the economy Z , and the Euro membership, may influence the *sensitivity* of spreads to the crisis. This may occur because (weak) fundamentals and EUZ membership may affect the crisis' impact on the the idiosyncratic risk drift (η), or/and because they may change the contagion vulnerability via the γ's. The idea is that during a crisis, investor may reassess the importance of market fundamentals, and revise the country's perceived idiosyncratic risk and its vulnerability to external contagion. In principle, membership of the Euro area may either reduce or raise these risks and vulnerabilities before or during a crisis, depending on the sign of the coefficient (δ, ϕ and η, γ)

In equation (2) the external factors $F_t \equiv \left[F_t^G, F_t^E, F_t^F\right]$ are measured as follows: F^G, the change the global risk factor, is defined by an index of Global (non-European) sovereigns CDS spreads; the European risk factor,F^E is measured by the change of an index of Western European sovereigns CDS spreads; the Financial risk factor, F^F is an index of CDS on private European Financial Institution. The composition of the indexes reflect respectively the Markit iTraxx SovX Global Liquid Investment Grade Index (comprising the most liquid high grade sovereign entities around the globe), the Markit iTraxx SovX Western Europe Index (comprising 11 members of the Eurozone plus Denmark, Norway, Sweden and United Kingdom) and the Markit iTraxx European Senior Financials Index (comprising 25 major financial institutions in Europe), see the Appendix for a list of sovereigns and financial institutions appearing in each index.

The evolution of these three Indexes across our sample period is shown in Figure 1. Besides the extremely high correlation among the three indexes, we observe an almost perfect comovement between the European Sovereigns and the European financial Indexes from 2010 to 2012. We do not to employ these indexes themselves, but we construct our own country specific indicators, for several reasons. First, we want to avoid the endogeneity and spurious correlation problems that arise when a European country's spread appears both as the dependent variable and in the European sovereign index. Hence we compute a country specific indicator by excluding each country i from the

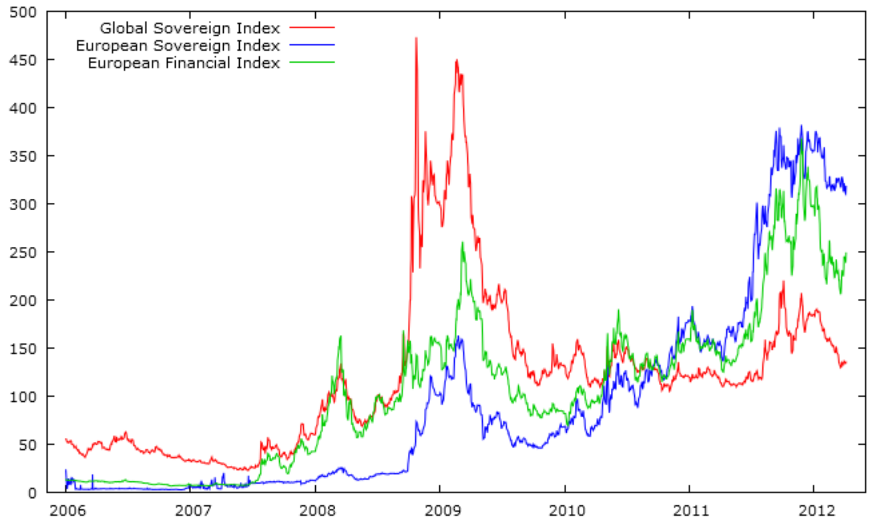

Figure 1: Plot of ITraxx Global Sov Index (excluding Western Europe), ITraxx European Sovereign Index (excluding Greece), Itraxx European Financial Index

index used in the i-th regression. Similarly, we want to exclude the Western European countries from the Markit iTraxx SovX Global Liquid Investment Grade Index, in order to avoid counting the same countries in two different variables.

Rather than using the original MArkit indexes, we construct our risk measures calculating the first principal components of the sovereign CDS included in the index. This procedure is justified by the empirical evidence (see Longstaff et al. 2011) that suggests that the first principal component of sovereign CDS is actually an almost equally weighted index of the single sovereigns' CDSs. Moreover, our indexes are appealing because they weight individual components in a way that maximizes the variance over all linear combinations of the underlying components, the CDS spreads. Thus they capture more effectively the "common component" of the risk indicators. The Principal component computations are performed recursively on each rolling windows for which regressions are estimated, and the resulting factor loadings, the weights of the indexes, are normalized to sum up to unity in each iteration.

Another problem of the market indexes is that they are highly correlated among themselves, as shown in the previous figure and suffer from feedback problems. Changes in investors' risk aversion stemming from, say, the US, are likely to affect European sovereigns as well as the European Financial sector, and similarly the consequences of the European debt crisis are likely to feed back into to global risks. This is even more true for the relation between the European Financial sector and European sovereigns. Acharya et. al (2011), for example, suggest that the financial sector bailouts have been an integral factor in igniting the rise of sovereign credit risk. A bail-out guarantees is typically accompanied by a shift of the credit risk from the banks to the sovereigns. In turn, the deterioration of sovereign creditworthiness feeds back to the financial sector itself: on the one hand, the fall in the market price of sovereign bonds deteriorates bank' asset side ("collateral damage") which hold larg chunks of the government debt; on the other, it reduces the value of the (implicit) public bail-out guarantee.

In order to clean our measures of risk factors from these endogeneity problems, following Bekaert, Hodrick and Zhang (2009), we orthogonalise the three factors. First, we extract the European sovereign component by regressing our European sovereign index on the Global sovereigns index, and by using the residual as our European Component: by construction, the calculated European sovereign risk factor does not reflect the movement of the sovereigns risks in the rest of the world. Similarly, we regress the European Financial index on both the Global and the European Sovereign component derived before. The residual of this regression is used as a Financial factor in the model. It captures those movements in the credit risk of the main European financial institutions which are not explained by or embedded in the movements of the Global or European sovereigns indexes. In this procedure we have chosen a particular "ordering" in the transmission of risks: from Global to European Sovereign to European Financial. In order to check the robustness of our results, we have also tried a different "ordering" between these factors: Global, European Financial, European Sovereign. The results do not change any meaningfully (and are available upon request).

3.2 The Data

Our preference for using CDS spreads as indicators of sovereign risk is well explained by Longstaff et Ang (2011), who argue that sovereign CDS data have the advantage, relative to sovereign bond yields, of being more liquid and allowing more accurate estimates of credit risks. Morover, because it might be easier to enter into a CDS contract than to buy/sell a certain bond, CDS prices have a tendency to incorporate information more quickly than prices in the bond markets (see Bomfim (2005).The sample period is 1 January 2006 to 29 march 2012. It contains 1630 daily observations on 15 European sovereign CDS spreads. Among these sovereigns, 11 belong to the Euro zone (Germany, France, Italy, Spain, Belgium, Greece, Portugal, Ireland, Netherland, Austria, Finland) and 4 do not (Sweden, Norway, UK and Northern Ireland, Denmark). By considering major economies both inside and outside the monetary union we can check whether contagion, if present, is mainly due to being a member of a single currency union or to spill-overs due to regional proximity. As a start date for the Greek (or European) sovereign debt crisis we take November 2009, when a new government lead by George Papandreu revised the 2009 Greek deficit from a previously estimated 5% to an alarming 12.7% of GDP. Besides, we performed a robustness analysis with the alternative starting-date of April 2010, when Standard & Poor's slashed Greece's sovereign rating to "junk" status. Data on CDS have been collected from Datastream by Thomson Reuters.

4 The Analytical Results

4.1 Estimation of the time-varying coefficients

The first step of the analysis consists in estimating the idiosyncratic (alpha) and contagion (beta) parameters of each country's spread, and in tracking their evolution overtime. To this end we estimate equation (2) recursively, country by country, by means of rolling regressions. In particular, we divide the sample into rolling windows, each consisting of 200 daily observations. We chose this window size in order to have enough observations in each sub-sample, while keeping a relatively large number of sample estimates. We tried with smaller/larger wsizes (150/300 observations) with similar results. Separatedly within each window, we apply the principal component analysis and the orthogonalization procedure outlined before, and construct the factors F. We then estimate equation (2) recursively by OLS, using five lags of the dependent variable to capture possible autocorrelation inside each subsample, for a total of 1430 regressions and point estimates. We retrieve the coefficients (alpha and betas) and we assigne them to the last observation of each subsample. For instance, if a window covers the period from 01/02/2006 to 01/10/2006, our estimates are labelled with the date 01/10/2006. In order to reduce noise, we transform the daily time series of parameter estimate into weekly series, by averaging coefficients across each week.

There are four parameters of interest. The first, α_{it}, is a country specific component (constant within each window) which is similar to a Jensen's alpha in a standard CAPM model. It captures the systematic part in the change in the sovereign spreads which is not explained by the interdependence with the market. As such, the α_{it} may capture idiosyncratic factors such as "appetite for risks" effects, that are unrelated to the the other market risk indexes. Positive and significant changes in the alphas may occur during the crisis (parameters η in equation 3), and may reflect "wake up calls" (parameters η_1). In particular, should a plurality of countries displays large and contemporaneous increases in their α_{it} , this would be a strong indicator of a change in risk aversion (a sort of "epidemic"), possibly due to herding behaviour, or to the coordination of investors on a particular equilibrium.

The other three parameters of interest are the betas, β^G_{it}, β^E_{it},β^E_{it}, which measure the association between the country's sovereign spread change and, respectively, the Global, European, and Financial risk factors. By looking at their evolution over time we can see how the relative importance of the different channels of interdependence changes since the US financial crisis into the Greek debt crisis. "Contagion" in this context means that the betas significantly rise during a crisis (parameter γ_i in equation 4). Such contagion may be induced either by an unconditional increase(γ_0) or by an increase due to market fundamentals $Z_{i,t-k}\left(\gamma_1'\right)$.

4.2 Analyzing the sources of time and cross-country variation in coefficients

The second step of our analysis consists in uncovering the determinants of time variation and cross-country difference in the alphas and in the betas and test for contagion. In order to perform the analysis, we stack the weekly time series of estimated parameters for each country in a single multi-country panel dataset which also contains the respective economic (lagged) variables $Z_{i,t-k}$. The latter comprise standard macroeconomic, financial variables and risk aversion indicators. In order to prevent the endogeneity problem that arises when stochastic shocks affect both the dependent (our estimated coefficient) and the explanatory variables (the "fundamentals"), we lag the latter by a quarter. We also need to address the issue of the different frequency of the observations. While CDS spreads are observable on a daily basis, most macroeconomic variables are available only on a monthly, quarterly or annual basis. Moreover, for several of these variables, the most recent data for 2012 are unavailable. In order to address the first problem we use linear interpolation to construct weekly observations from monthly, quarterly and annual observations, which means that we assume that macroeconomic variables evolve smoothly over time. For the second problem we replace the missing Eurostat data for 2012 with the AMECO macroeconomic forecasts.

We include a wide range of country-specific macroeconomic indicators: the public debt/GDP ratio, the budget deficit/GDP ratio, the current account balance as percentage of GDP, the percentage change in industrial production. Also, we employ trade openess, exports plus imports scaled by GDP, as the trade channel has often been associated with international spillovers (see Eichengreen et al. (1996), Forbes (2001), Kamisky and Reinhart (2000)). In particular, the large trade integration within the European Union may play a role in the transmission of shocks. We proxy international risk aversion through the VIX Index (Chicago Board Options Exchange Market Volatility

Index) which measures the market's expectation of the stock market volatility over the next 30 days. We use the TED spread (the difference between the three-month LIBOR and the three-month T-bill interest rate) as indicator of liquidity in the inter-bank market and possibly of credit risk of the banking sector. Finally, we convert Moodys' rating on a 0-23 scale, and we take the unexplaind residual of a regression of these "notches" on the previously listed economic variables, so as to construct a measure of the "new information" content of the ratings.

Equations (5) and (6) allow us to test for the the "wake up call hypothesis" discussed above, by means of a t-test on the γ and η coefficients. Also note that under the maintained hypotheses of our model, we can interpret the share of the variance of the alpha and beta regressions that can be explained by our economic variables as a measure of the empirical support to the "fundamentalist" view of contagion (vulnerability depends on fundamentals) while the unexplained variance can either be attributed to the "multiple equilibria/credibility" view or to a misspecification of the model.

We estimate the equations (3) to (6) by means of pooled OLS. Because we have several macroeconomic variables which are likely to be highly correlated, collinearity may be a problem, generating many insignificant regressors. We use the "general to specific" approach of David Hendry (Hendry and Krolzig 2004): we start by estimating the model with all the variables, and then we eliminate those which are not significant at 15% level. This high threshold is needed in order not to exclude potentially important regressors. We proceed step by step by excluding individual variables, and simultaneously testing, at each step, whether an already excluded variable should be included again, until we arrive at a final encompassing model specification. A particular variable is kept in the specification if either its coefficient β_1 or its contagion parameter γ_1 are statistically significant.

4.3 Step One: Rolling Regressions

Next we describe the behaviour across time of the estimated coefficients of equation (2). The first parameter, see Figure 2-3, is α_{it}. The alpha traces the systematic movement in idiosyncratic risk, e.g. the "drift" in the country's CDS spread daily change. This is a "domestic" component, since, by construction, is unrelated to "external" (global, european, financial) factors included in the model. When this parameter spikes simultaneously for many countries, we have an indication the market is hit by some sort of "panic", possibly resulting from herd behavior, a rise in risk aversion, a coordinated shift in expectations, affecting many countries at once. In Figures 2-3 we show for each country the estimates obtained. For clarity of presentation we set to zero the estimates which are not significantly different from 0 at a 5% confidence level (the values set to zero are indeed very small, so that we do not set to zero "large" estimates that also have large dtandard deviations). The effects of the US subprime crisis (September 2008 and March 2009) and the Greek Crisis (around November 2009) are evident in the data: the jumps in the alpha coefficients are clustered around these episodes (notice that the scale for Greece in the graph is different, for obvious reasons). There are three interesting features in the graphs. First, countries differ substantially as to the impact of the crises, that is, the size of the individual jumps of the alphas. Countries naturally divide themselves into three "sizes": Small (Finland, Germany and Norway), Medium (Sweden, Denmark, the Netherlands, Belgium, France, the UK, and Austria on the high side) and Large (the "periphery": Spain, Italy, Ireland Portugal, Greece). Second, while the US subprime earthquake affected *all* Europeans, albeit with different magnitudes (Ireland, followed by Austria and the UK being the most affected), the Greek crisis is largely a matter for the *Eurozone*. Norway, Sweden, the UK and Denmark, which do not belong to the Euro, were hardly affected. Finally, differences *inside the Eurozone* are at least as remarkable as those between member and non members: only France, Belgium, Italy, Spain, Ireland and Portugal show large and recurrent spikes in idiosyncratic risk. It is worth noticing that Ireland, which required a formal bailout on november 2010, was not really affected by the Greek crisis before August 2010. This is consistent with the view that Irish problems are mainly the consequence of the bailout of the banking sector in the wake of the US Financial crisis, although the Greek crisis may well have aggravated the risks. The evidence is different for Portugal, that experienced a long period of increasing spread drift before its final request of help on April 2011. Interestingly, Italy did not experience substantial loss of confidence until September 2011, when Italian bonds were under attack forcing the resignation of Silvio Berlusconi's government in November. Interestingly, spikes in the Italian graph correspond, even if in a more limited fashion, to spikes in the graph of France, Spain, Belgium, the Netherlands, Denmark, Austria. This suggests that problems in Italy might potentially cause contagion effects not limited to the "perifery" of the Monetary Union.

The other parameters of interest are the beta coefficients $\beta_{it} \equiv \left[\beta_{it}^{Glob}, \beta_{it}^{Eur}, \beta_{it}^{Fin}\right]$. These capture the dependence of each sovereign CDS on the three market indexes considered, β^{Glob} the global risk component, β^{Eur} the European sovereign specific component (orthogonal to the previous index), and β^{Fin} the European Financials CDS Index (again othogonal to the previous two). These betas are modelled to depend on economic fundamentals, on our measure of risk aversion, the VIX, and on the crisis dummy. Before getting into the formal econometric analysis, it is useful to plot the evolution of these "channels of interdependence" in order to shed some light on the sources of contagion. The estimates are reported in Figures 4-5. As before, the scale is different for Greece, and we only report coefficients that are significantly different from 0 at a 5% confidence level.

There are a few interesting features. First, before the outset of the US subprime crisis, around September 2008, there seems to be no significant interdependence in sovereign risks. European sovereigns were perceived as low-risk entities and CDS spreads were extremely stable. Starting from September 2008, however, sovereign credit risks began to be priced for almost all of the countries in the sample. We observe a sharp and generalized increase in the comovement of sovereign spreads in Europe, which translates in a remarkable increase in the sensitivity parameterβ^{Eur} (the blue line). These parameters range between 0.5 and 2 , with values which are higher for Ireland and Austria, Italy, Spain and Portugal, reach the value 1 for UK, Sweden, Denmark, the Netherlands, and are around 0.5 for most other countries. Thus, initially

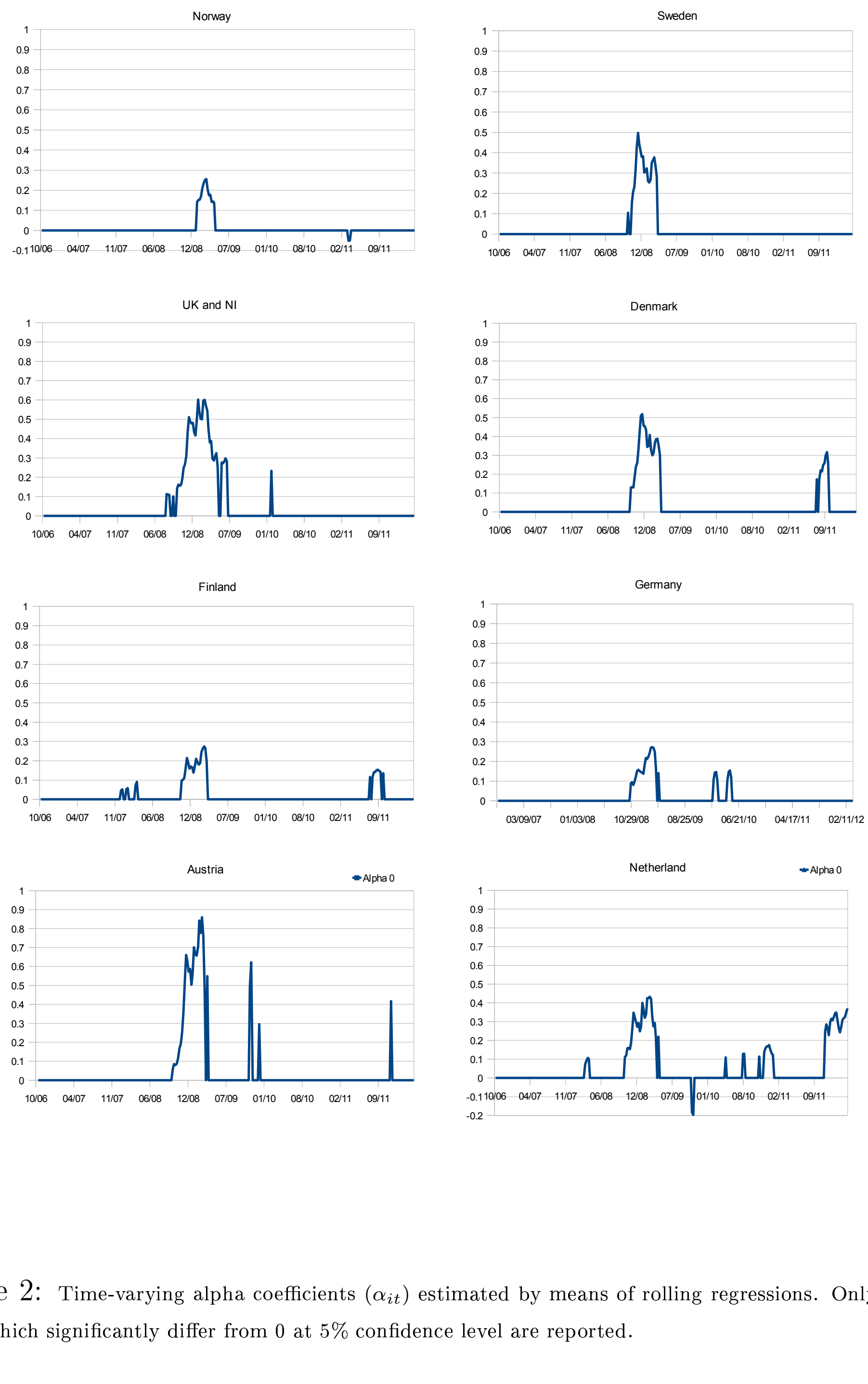

Figure 2: Time-varying alpha coefficients (α_{it}) estimated by means of rolling regressions. Only coefficients which significantly differ from 0 at 5% confidence level are reported.

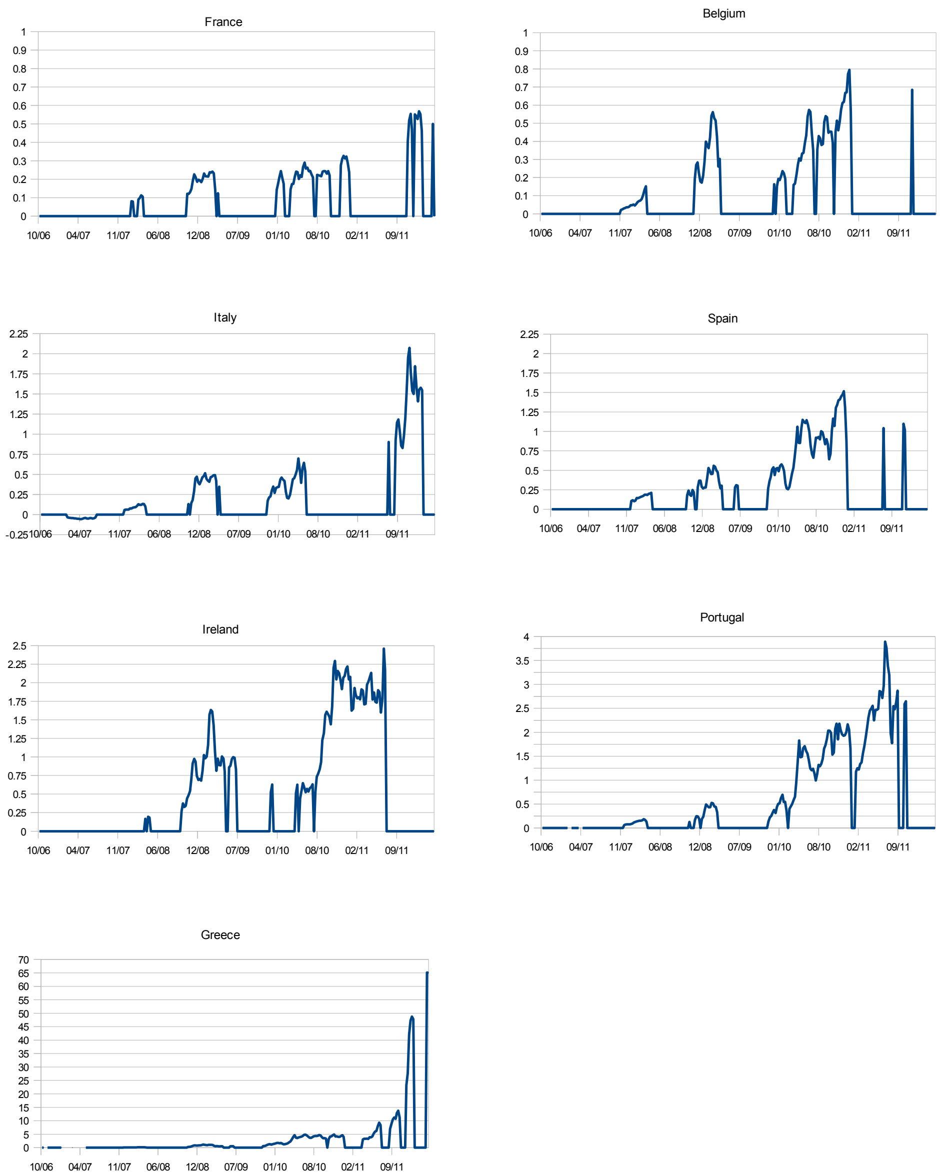

Figure 3: Time-varying alpha coefficients (α_{it}) estimated by means of rolling regressions. Only coefficients which are significantly differ from 0 at 5% confidence level are reported.

it seems that European countries, inside and outside the Euro, were similarly affected by European sovereign risk. Things change dramatically at the onset of the Greek crisis. From November 2009 the differences among European countries rise sharply. Southern European and Irish CDS become much more sensitive to movements in the European sovereign Index. Conversely, the β^{Eur} coefficient *falls* below 0.5 in "core" European countries: even countries such as Austria and The Netherlands, that had experienced hightened sensitivity during the US financial crisis, now display a sharp *decline* in their European beta. Conversely, among peripheral countries, Italy, Spain and Ireland show high *persistence* in their spread sensitivity, while Portugal and Greece experience a sharp further increase.

The red line corresponds to the behaviour of the β^{Glob} parameer, which measures the sensitivity of the country's spread change to global sovereign risk. Initially this parameter is very small and insignificant for almost all countries, at least until July 2009 when it starts rising. Eventually, β^{Glob} overtakes the β^{Eur} around mid 2010, and keeps moving up, although at different speeds, in France, Belgium, Italy, Portugal, Denmark, Austria and Germany, while stabilizing towards the end of the period for the other countries. The increase is "small" for Germany, Finland, Netherland; "medium" for France, Austria and Belgium; and "large" for Italy, Spain, Portugal, Ireland, Greece. Most notably, around March 2010 we observe a simultaneous large break in the parameter for Italy, Spain and Portugal: on the wake of a possible downgrade of Greece to "junk" status, these countries were suddenly perceived more vulnerable to the global economic outlook and started to amplify movements of the global index. These patterns hold irrespectively of the proxy for global risk: if we replace Global Sovereign Index with the S&P500 we get similar results.

Finally, the green line in the figures shows the European Financial risk component, β^{Fin}. Until about August 2010, this is almost alwas insignificant in determining sovereign CDS variations. But as we proceed in time we observe a general increase in the sensitivity to the financial risk index, which parrallels the rise in global risks and the decline in the European risks, as if the sensitivity sovereign crisis originating in Greece had been transferred, on the one hand, to

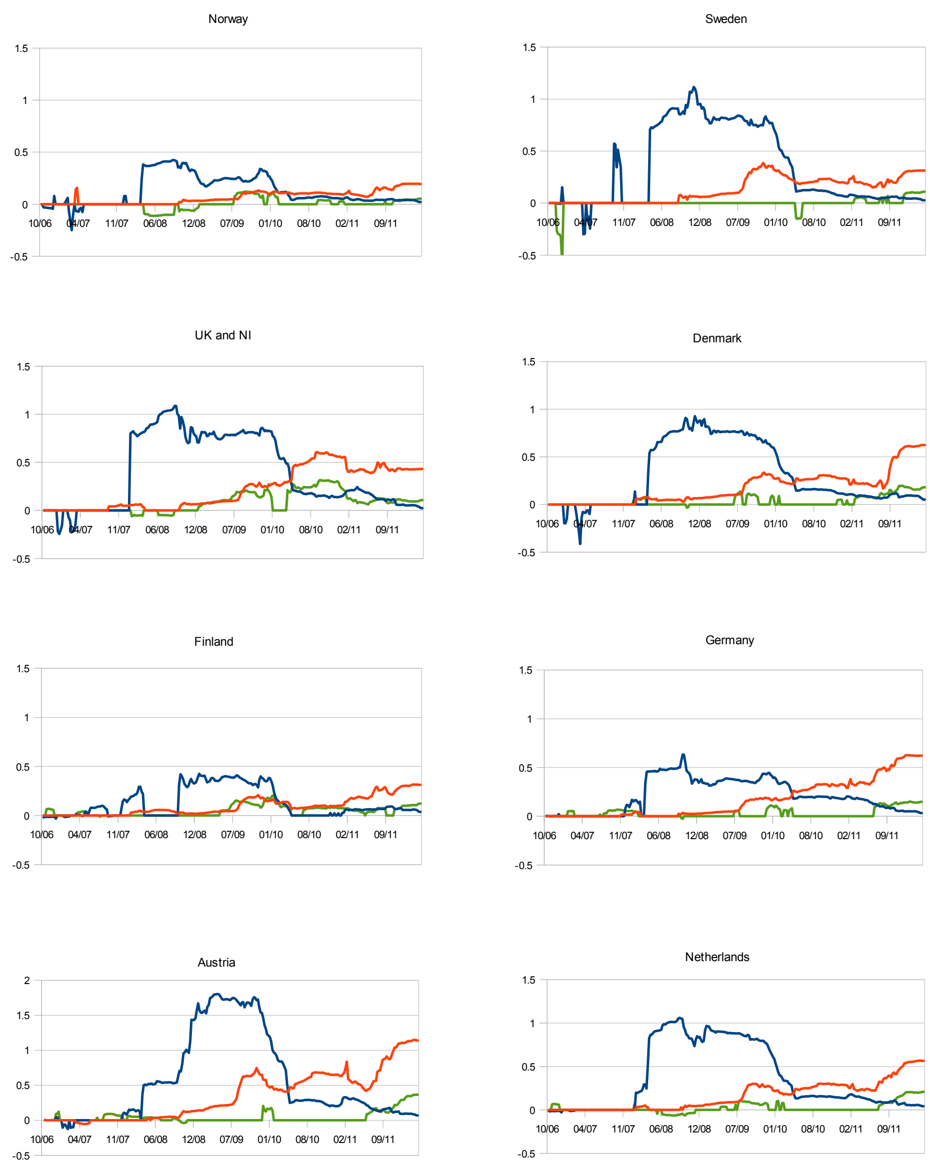

Figure 4: Time-varying beta coefficients (β^{Glob}- red line, β^{Eur}- blue line, β^{Fin} - green line) estimated by means of rolling regressions. Only coefficients which significantly differ from 0 at 5% confidence level are reported.

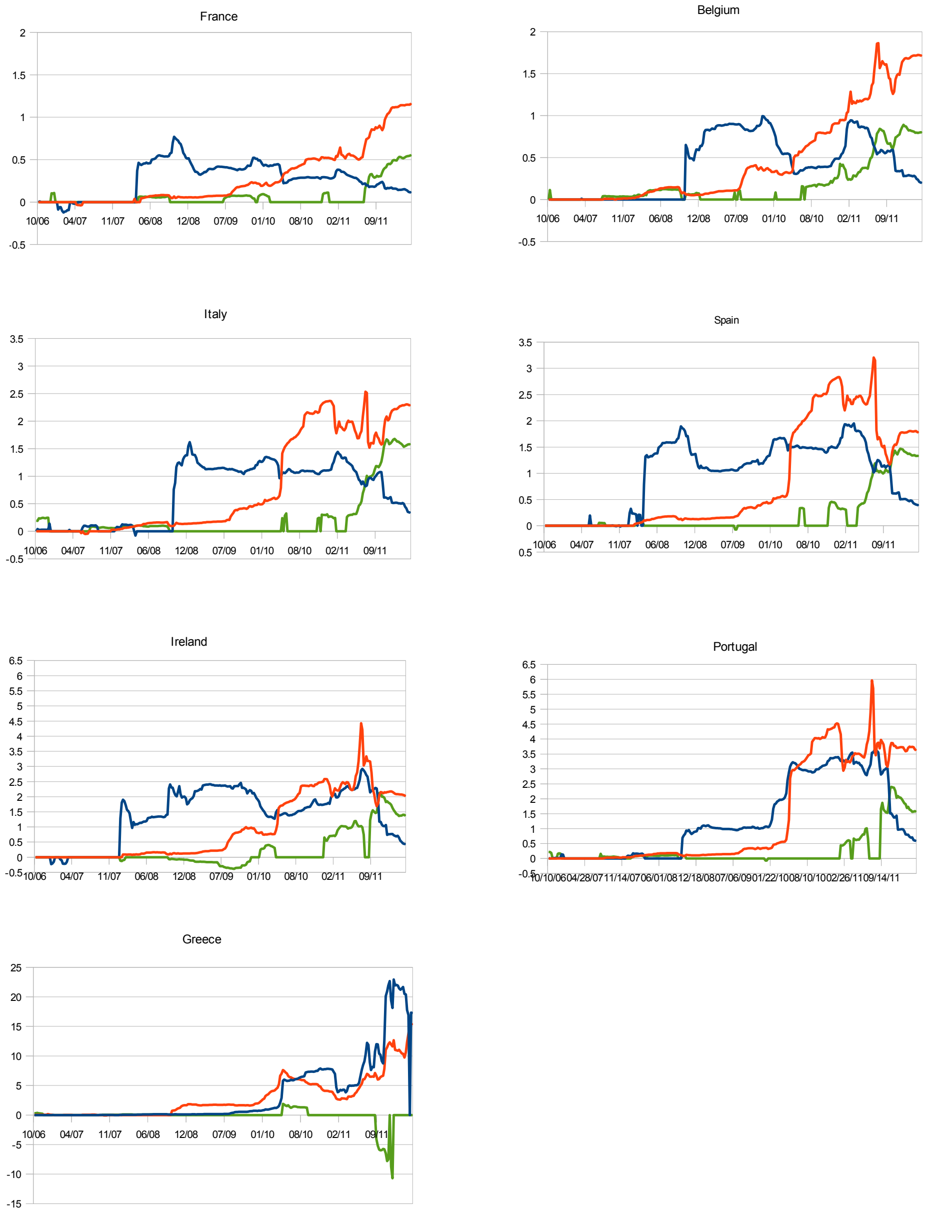

Figure 5: Time-varying beta coefficients (β^{Glob} - red line, β^{Eur} - blue line, β^{Fin} - green line) estimated by means of rolling regressions. Only coefficients which significantly differ from 0 at 5% confidence level are reported.

the vulnerability to the Global sovereign risk component, and. on the other, to the sensitivity to the European banks risks. This is most noticeble in Italy and Spain, two countries that between August and November, experienced severe attacks on the bond markets, leading to ECB massive interventions. In Germany and Northern European countries, the interdependence with the financial factor became significant only later, in July 2011, at the time when a private sector involvement (PSI) agreement was included in the second bail-out package for Greece.

4.4 StepTwo: Explaining Contagion

In order to understand the reasons behind the different vulnerabilities to contagion, the betas, and to "panic", the alphas, we use panel estimation. We regress our countries' time varying parameters on the respective (lagged) economic fundamentals (trade openness, the public debt/GDP ratio, the budget deficit/GDP ratio, the current account balance as percentage of GDP, the rate of unemployment, the monthly change in industrial production), on the sovereigns' credit rating innovations, on an index of market volatility (the VIX), on a liquidity measure of the inter-bank market (the TED spread), a crisis dummy (which takes the value of one from November 2009, when the estimate for the Greek 2009 budget deficit was raised from 5 to 12.7%) and on a Euro Zone dummy. We have excluded Greece from our sample, because this country is likely to be "the "source" of systemic risk, so that its parameter estimates may affected by strong endogeneity problems. In fact, Greek alphas and betas take extreme values and should be considered as outliers which, if included, would probably bias our estimates. We report the results of the estimation in Tables 1-4.

Alpha coefficients. Table 1 presents the results for the idyiosyncratic risk component. The first column (interdep α_1', see equation 3) shows the "direct" effect of economic fundamentals on the idiosyncratic drift of the spread. The fourth column (η_1' crisis, see equation 5) reports the "indirect" additional effect of the economic fundamental during a crisis. Thus, for example in the first column, third row, we read that a one percent increase in the rate of growth of industrial production significantly reduces the idiosyncratic component of the spread change by 0.4%. The η_1' coefficient in the fourth column tell us that during the crisis this effect is magnified by an extra -1.1% so that the total effect in a crisis sums up to a reduction in the drift of 1.5%. The sign of direct effects of the significant coefficients conform to our *a priori* : the rate of growth in industrial production enters with a negative sign, so that a larger growth rate is associated to a lower idiosyncratic vulnerability; the ratio of the budget deficit to GDP and the volatility index enter with positive sign, so they are both associated with higher sovereign risk drift. These are the only variable that show significant "direct" effects on the sovereign risk drift: the other variables, the current account balance, the public debt ratio, the unemployment rate and trade openness, are not statistically different from zero. Things change quite dramatically during the crisis (see the η_1' coefficients in the third column). First, we see that during a crisis the constant term of the equation turns positive and significant. More interestingly, countries belonging to the EUZ (see the dummy coefficient) have an additional vulnerability to idiosyncratic risks so that Euro-membership adds an extra 0,34% to the sovereign spread change relative to non EUZ members. Note that EUZ dummy was not statistically different from zero outside the crisis. Also, we see that the crisis amplifies the effect of growth on the idiosyncratic risk component. Finally, observe that the ratio of debt to GDP, the rate of unemployment, and Moody's rating innovations, which had *no* significant direct effect in normal times, become significantly and positively associated to a country's idiosyncratic risk in the crisis. This suggests that while markets tend to ignore solvency measures, credit agencies' ratings and labor market developments in normal times, under period of stress these variable convey useful information on sovereign default risks. The same is true for trade opennes, possibly reflecting the role of current account imbalances in countries such as Spain and Ireland. The conclusion here is that financial markets which "benignly" neglected fundamentals, got a sudden "wake up call" with the crisis. It is important to point out that the corrected R^2 coefficient shows that our macro-economic fundamentals can account for about 54% of the cross-country differences in idiosyncratic sovereign

Pooled OLS, using 2665 observations
13 Units cross section
Dependent variable: α_t
Robust Standard errors (HAC)

	interd. (α)	Std. Error	p-value	crisis (η)	Std. Error	p-value
const	−0,166265	0,366462	0,6501	−0,229747	0,113195	0,0425 **
EZ	−0,0437684	0,0586939	0,4559	0,346037	0,160526	0,0312 **
Industrial Prod.	−0,00456631	0,00251173	0,0692 *	−0,0111891	0,00447375	0,0124 **
Public Debt	−0,00238887	0,00254621	0,3482	0,00601242	0,00263260	0,0225 **
Public Deficit	0,0256049	0,0136868	0,0615 *	−0,000389891	0,000531999	0,4637
Current Account	−0,00953192	0,00646830	0,1407	0,00270353	0,00196413	0,1688
Unemployment	−0,00532230	0,0228851	0,8161	0,0233754	0,0103858	0,0245 **
Trade Open	0,00151996	0,00127177	0,2321	−0,00344331	0,000915407	0,0002 ***
Rating	0,0495670	0,0635503	0,4355	−0,276175	0,0935336	0,0032 ***
VIX	0,00797780	0,00105036	0,0000 ***	−0,00703624	0,00424160	0,0973 *
TED	0,0190308	0,0131000	0,1464	−0,112881	0,249257	0,6507

Average dependent variable	0,288530	SQM dependent var.	0,493629
Squared sum of residuals	295,0123	S.E. of the regression	0,334096
R^2	0,545531	R^2 corrected	0,541920
$F(21, 2643)$	151,0752	P-value(F)	0,000000
Log-likelihood	−848,7158	Akaike Criterion	1741,432
Schwarz Criterion	1870,967	Hannan–Quinn	1788,306

Table 1: The table shows the estimates of the coefficients of the following regression

$$\alpha_{i,t} = \alpha_0 + \alpha_1^{'} Z_{i,t-k} + \eta_{i,t} CR_t + \delta EUZ + u_{i,ti,t},$$
$$\eta_{i,t} = \eta_0 + \eta_1^{'} Z_{i,t-k} + \eta_2 EUZ$$

where in the constant parameter we have introduced an Euro-Zone dummy (EZ) in order to control for fixed effects at the Euro-Zone level. We report*negative for EZ* the $\beta_1$and γ_1 coefficients, which are the coefficients on the $Z_{i,t-k}$ instruments that survive an encompassing approach of variable selection where each variable is kept in the regression if either the interdependence coefficient β or the crisis parameter γ of a particular variable is statistically significant. ***, **, and *, indicate statistical significance at the 1%, 5% and 10% respectively.

risk changes.

Beta Global Sovereigns. We saw that the parameter β^{Glob} , which represents a country's vulnerability to "global sovereign risks", increases significantly during the Greek crisis, albeit with different intensity, for almost all of the countries of the Eurozone, and in particular in the "perifery" (Spain, Italy, Portugal, Ireland). It is therefore interesting to understand which macroeconomic imbalances are "reponsible" for this. In the model, it turns out that four variables have a significant direct effects *before the outset* of the Greek debt crisis (see the first column of Table 2 which reports the β_1' parameters in equation 4): the public debt/GDP ratio (positive sign), the current account balance over GDP (negative sign), trade openess (positive sign), the EZ membership (negative sign). Interestingly, in normal times the global sensitivity is zero on average (see the constant term) but it is *negative for EUZ* members: the common currency shelters its members from global contagion relative to non members. However, during the crisis the EUZ dummy variable turns *positive* (and significant), making the total effect positive (-0.216859 + 0.585314). Euro membership makes countries more exposed to global contagion. As with the α coefficients, the fourth column of Table 2 shows that the solvency indicator (public debt GDP ratio) becomes significantly more important in explaining sensitivity to global contagion; the "real" macro fundamentals such as the rate of unemployment, the growth of industrial production, as well as the credit ratings and the VIX volatility index, which were not relevant in normal times, become statistically significant with the expected sign during the crisis. Our variables toghether explain around 75% of the cross-country variation in the exposure to global sovereign risk.

Beta European Sovereigns. In Figure 4 we saw that the European contagion parameters β^{Eur} varied in a very narrow range before the crisis, but became much more diverse in the crisis, mainly reflecting the dichotomy between the Euro-Zone "core" and "perifery". Our empirical findings in this section suggest that these developments largely reflect an increased market sensitivity to macroeconomic fundamentals. Before the Greek crisis (see the second column of Table 3), the only economic variables which significantly affect the European contagion parameters are the public debt/GDP ratio (with positive sign), the growth of industrial production (negative sign) , trade openess (also positive) and the volatility VIX index (positive). Interestingly, EUZ members are *less* vulnerable to European Sovereigns shocks than non EUZ countries. The TED spread is strogly significant but has the "wrong" (i.e negative) sign. The landscape change dramatically during the crisis (see the fourth column). Euro members become *more* vulnerable to European Sovereign contagion; the effect of the debt ratio and of the growth rate becomes larger, while that of the deficit ratio smaller (its cumulative effect slightly shrinks to 0.0065 - 0.0011);

Pooled OLS, using 2665 observations
13 Units cross section
Dependent variable: β_t^{Glob}
Robust Standard errors (HAC)

	interd. (β)	Std. Error	p-value	crisis (γ)	Std. Error	p-value
const	−0,727250	0,535742	0,1747	−0,479187	0,213632	0,0250 **
EZ	−0,216859	0,07493189	0,0038 ***	0,585314	0,264396	0,0269 **
Industrial Prod.	−0,0201525	0,00418808	0,2857	−0,0201525	0,00418808	0,000 ***
Public Debt	0,00518863	0,00255951	0,0427 **	0,00925061	0,00348420	0,0080 ***
Public Deficit	−0,00370562	0,0151459	0,8067	0,00109129	0,000759264	0,1508
Current Account	−0,0225463	0,0112377	0,0449 **	0,00206343	0,00314830	0,5123
Unemployment	0,0351711	0,0332169	0,2898	0,0571232	0,0200701	0,0045 ***
Trade Open	0,00478264	0,002222321	0,0315 **	−0,0045512	0,00178745	0,0109 **
Rating	−0,0666338	0,113844	0,5584	−0,205574	0,143024	0,1507 ***
VIX	0,000680143	0,00104845	0,5166	−0,0117996	0,00393176	0,0027 ***
TED	−0,0194730	0,0155205	0,2097	0,123759	0,419739	0,7681

Average dependent variable	0,637784	SQM dependent var.	0,895060
Squared sum of residuals	541,7683	S.E. of the regression	0,746151
R^2	0,746151	R^2 corrected	0,744134
$F(21, 2643)$	369,9387	P-value(F)	0,000000
Log-likelihood	−1658,638	Akaike Criterion	3361,275
Schwarz Criterion	3490,810	Hannan–Quinn	3408,150

Table 2: The table shows the estimates of the coefficients of the following regression

$$\beta_{i,t}^{Glob} = \beta_0 + \beta_1^{'} Z_{i,t-k} + \gamma_{i,t} CR_t + \phi EUZ + v_{i,t},$$
$$\gamma_{i,t} = \gamma_0 + \gamma_1^{'} Z_{i,t-k} + \gamma_2 EUZ$$

where in the constant parameter we have introduced an Euro-Zone dummy (EZ) in order to control for fixed effects at the Euro-Zone level. We report the β_1' and γ_1' coefficients, which are the coefficients on the $Z_{i,t-k}$ variables that survive an encompassing approach of variable selection where each variable is kept in the regression if either the interdependence coefficient β or the crisis parameter γ of a particular variable is statistically significant. ***, **, and *, indicate statistical significance at the 1%, 5% and 10% respectively.

Pooled OLS, using 2665 observations
13 Units cross section
Dependent variable: β^{Eur}
Robust Standard errors (HAC)

	interd. (β)	Std. Error	p-value	crisis (γ)	Std. Error	p-value
const	−0,631694	0,401305	0,1156	−0,437127	0,136106	0,0013 ***
EZ	−0,186255	0,0642000	0,0037 ***	0,459021	0,177297	0,0097 ***
Industrial Prod.	−0,00306904	0,00431175	0,4767 *	−0,0156621	0,00338892	0,0000 **
Public Debt	0,00502986	0,00215375	0,0196 **	0,00723209	0,00229990	0,0017 ***
Public Deficit	0,00646770	0,0111144	0,5607 *	−0,00106919	0,000477892	0,0253 **
Current Account	−0,00990861	0,00871749	0,2558	0,000272754	0,00222550	0,9025
Unemployment	0,0366050	0,0280228	0,1916	0,0431531	0,0157612	0,0062 ***
Trade	0,00394249	0,00168578	0,0227 **	−0,00234837	0,00136652	0,0858 *
Rating	−0,00306904	0,105767	0,4771	−0,163742	0,114940	0,1544
VIX	0,00149434	0,000793704	0,0598 *	−0,00960705	0,00226878	0,0000 ***
TED	−0,0480093	0,0170268	0,0048 ***	−0,204725	0,329137	0,5340

Average dependent variable	0,458345	SQM dependent var.	0,672040
Squared sum of residuals	233,2466	S.E. of the regression	0,297070
R^2	0,806139	R^2 corrected	0,804598
$F(21, 2643)$	523,3553	P-value(F)	0,000000
Log-likelihood	−535,6837	Akaike Criterion	1115,367
Schwarz Criterion	1244,903	Hannan–Quinn	1162,242

Table 3: The table shows the estimates of the coefficients of the following regression

$$\beta_{i,t}^{Eur} = \beta_0 + \beta_1^{'} Z_{i,t-k} + \gamma_{i,t} CR_t + v_{i,t},$$
$$\gamma_{i,t} = \gamma_0 + \gamma_1^{'} Z_{i,t-k}$$

where in the constant parameter we have introduced an Euro-Zone dummy (EZ) in order to control for fixed effects at the Euro-Zone level. We report the $\beta_1$and γ_1 coefficients, which are the coefficients on the $Z_{i,t-k}$ instruments that survive an encompassing approach of variable selection where each variable is kept in the regression if either the interdependence coefficient β or the crisis parameter γ of a particular variable is statistically significant. ***, **, and *, indicate statistical significance at the 1%, 5% and 10% respectively.

the unemployment rate, rate and the VIX index start to matter, while the effect of trade openness disappears. Thus, as before, the crisis exacerbates the impact of the real economy on the contagion parameter. A particularly striking feature is the lessened role of the budget deficit, as opposed to that of the debt: this suggest that the European strategy focusing on deficit reduction, rather than privatization and debt reduction, may backfire in terms of risk premia if it is associated to a sharp reduction in the growth rate. Again, the fit of the regression is encouraging: an R^2 close to 80%, implies that fundamentals can account for most of the cross-country variation in exposure to European contagion.

Beta European Financial. As of July 2011, the sensitivity of sovereigns spreads to the European financial sector risk has also increased, albeit not uniformly. For Ireland, Spain and Italy this is not surprising, as in the former two countries the bail-out costs of the banking sector has wrecked government finances, while Italian banks holds about one third of the government debt. The econometric analysis delivers a few surprising results. From Table 4 we see that, once again, the crisis turns EUZ memberships from a source of resilience to a source of weakness to banking contagion. The role of the current account is unaffected during the recent crisis, while the importance of trade openness (0.0053 - 0.0048) and the volatility VIX index (0.00526065 - 0.00452) tend to vanish at times of crisis. Interestingly, the public debt variable does *not* significantly affect the sensitivity of the sovereign spread change to European financial risk (at the 15% confidence), neither before nor after the crisis and this variable has been eliminated from our regression. Remember however that by construction the Financial index is orthogonal to the EU sovereign index, so that the the banking risk components that reflects sovereign risk, the lower bail-out guarantee and risk of capital losses on government bonds, are already netted out from the financial index. Once again, unemployment and growth are significant *only* during the crisis. The coefficient associated to the TED spread and credit ratings seem counter intuitive.The TED indicator has a negative sign, suggesting that when liquidity dries up in the credit market, the sensivity of sovereigns to the financial sector tends to fall. The second parameter behaves differently outside and inside the crisis: in normal times a sovereign upgrade by Moody's is associated to a larger financial contagion, which is counter intuitive; however, the rating coefficient assumes the "right" sign (negative, 0.284096 - 0.355748) during the crisis, suggesting that in bad times a downgrade raises the sovereign risk vulnerability to financial risk.

We have performed a roubustness check in order to make sure that our results do not depend on the orthogonalization ordering that we have assumed (Global-European-Financial). We have tried the Global-Financial-European ordering, by first regressing our Financial index on the Global one and extracting the financial innovation, and then by regressing the European sovereign

Pooled OLS, using 2665 observations
13 Units cross section
Dependent variable: β^{Fin}
Robust Standard errors (HAC)

	interd. (β)	Std. Error	p-value	crisis (γ)	Std. Error	p-value
const	0,147771	0,376528	0,6948	−0,0599768	0,234504	0,7982
EZ	−0,420462	0,102473	0,0000 ***	0,891090	0,236498	0,0002 ***
Industrial Prod.	−0,00350558	0,00804364	0,6630	−0,0169305	0,00773520	0,0287 **
Public Deficit	0,0220864	0,0157803	0,1617	−0,00140381	0,000869854	0,1067
Current Acc.	−0,0316340	0,00933279	0,0007 ***	0,00197756	0,00315168	0,5304
Unemployment	0,0263014	0,0306666	0,3912	0,0388029	0,0184463	0,0355 **
Trade	0,00531303	0,00280675	0,0585 *	−0,00488395	0,00161360	0,0025 ***
Rating	0,284096	0,121256	0,0192 **	−0,355748	0,118101	0,0026 ***
VIX	0,00526065	0,00272891	0,0540 *	−0,00452019	0,00249649	0,0818 *
TED	−0,00722731	0,0426140	0,8653	−1,36084	0,446051	0,0023 ***

Average dependent variable	0,733948	SQM dependent var.	0,721028
Squared sum of residuals	515,6050	S.E. of the regression	0,441515
R^2	0,627713	R^2 corrected	0,625038
$F(19, 2645)$	234,7225	P-value(F)	0,000000
Log-likelihood	−1592,682	Akaike Criterion	3225,365
Schwarz Criterion	3343,124	Hannan–Quinn	3267,978

Table 4: The table shows the estimates of the coefficients of the following regression

$$\beta_{i,t}^{Fin} = \beta_0 + \beta_1^{'} Z_{i,t-k} + \gamma_{i,t} CR_t + v_{i,t},$$
$$\gamma_{i,t} = \gamma_0 + \gamma_1^{'} Z_{i,t-k}$$

where in the constant parameter we have introduced an Euro-Zone dummy (EZ) in order to control for fixed effects at the Euro-Zone level. We report the $\beta_1$and γ_1 coefficients, which are the coefficients on the $Z_{i,t-k}$ instruments that survive an encompassing approach of variable selection where each variable is kept in the regression if either the interdependence coefficient β or the crisis parameter γ of a particular variable is statistically significant. ***, **, and *, indicate statistical significance at the 1%, 5% and 10% respectively.

index on the Global index and the Financial innovation and using the residual as our “pure” European sovereign risk measure.The results of the analysis, available from the authors, are almost identical to the ones that we have presented.

5 Summary and Conclusions

Table 5 summarizes our main findings from a qualitative point of view. First, during the Greek crisis “market sentiment” shifts against the Eurozone countries: before the crisis there is evidence of a *positive* “Eurozone effect”, so that the common currency “protected” its members from sovereign idiosyncratic and contagion risks; however, the Euro membership becomes an *handicap* during the Greek crisis, which basically turns into a Euro issue: for given "fundamentals" EUZ countries see the perception of sovereign risk rise relative to countries non belonging to the Euro. Second, with the exception of the vulnerability to "pure" financial risk, the role of the public debt ratio in accounting for both contagion and idiosyncratic risks is heightened during the crisis. Third, the real economy and the labor market become more important for sovereign risk during the crisis: lower growth of industrial production raises a country idiosyncratic and contagion risks, and higher unemployment, which was had no significant association with sovereign risk before the crisis, becomes associated to higher CDS spreads changes and contagion. One possible interpretation is the political economy of fiscal and current account consolidation: high levels of unemployment make fiscal consolidations more difficult to implement and to sustain; high unemployment is a sign of downward wage rigidity, which is also an obstacle for restoring competitiveness. Fourth, credit rating "news" which do not affect sovereign spreads in normal times, have a significant impact on sovereign risk during the crisis.

This evidence supports the conclusion that after a long period of "benign neglect" in the Eurozone, financial markets have rediscovered that fundamentals and structural fragilities impeding growth matter for sovereign risk. Overall, the economic variables that we choose for assessing the role of market fundamentals go a long way in accounting for the cross-country variation in idiosyncratic and contagion risks: they can explain between 54 and 80% of the total cross-country variance.

These results have important implications for the appropriate pace of adjustment in the Euro area. First, they imply that "credibility" is not "everything", in the sense that past economic fundamentals, as opposed to mere policy announcements, matter: they explain most of a country's vulnerability. This implies that policies that plunge the economy into recession backlash (recall that Greece, the obvious example, is *not* part of our empirical analysis) The reason it is not the standard story that the recession widens the public deficit through the automatic stabilizers, and this worsens the country's sol-

	α			β^{Glob}			β^{Eur}			
	interdip	crisis	total	interdip	crisis	total	interdip	crisis	total	interdip
Const		-	-		-	-		-	-	
EUZ		+	+	-	+	+	-	+	+	-
Ind Prod	-	-	-		-	-	-	-	-	
Pub Debt		+	+	+	+	+	+	+	+	
Pub Deficit	+		+				+	-	+	
Curr Acc				-		-				-
Unempl		+	+		+	+		+	+	
Trad Open		-	-	+	-	=	+	-	+	+
Rating		-	-		-	-				+
VIX	+	-	=		-	-	+	-	−	+
TED							-		-	

Table 5: This table summarizes the signs of the coefficients associated to the different instruments. Only coefficients which are significant at 10% level are reported. The column "total" shows the sign resulting from the sum of the interdependence coefficient and the crisis parameter.

vency. The effect works via a direct link from lower employment and growth to spreads: the recession raises the perception of insolvency risk. Second, labor market reforms may backlash if they raise unemployment in the short run. Measures aiming at reducing hiring and firing cost, for example, should be accompanied by reforms of the wage bargaining system in order to prevent the rise in unemployment. Third, privatizations should be part of a consolidation strategy, not only because they do not adversely affect the economy, but also because, by reducing debt stock, they may calm fears of insolvency which attach more weight to debt in the crisis

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Appendix I

The following table shows the actual composition of the three Market Indexes used in the model:

Global Sovereign CDS Index	European Sovereign CDS Index	European Financial CDS Index
Australia	Germany	Aegon N.V.
Japan	France	Allianz SE
Malaysia	Ireland	Assicurazioni Generali SPA
China	Belgium	Aviva plc
Korea	Denmark	AXA
Czech Republic	Norway	Monte dei Paschi di Siena SPA
Bulgaria	Spain	Banco Bilbao VA S.A.
Kazakhstan	Sweden	Banco Santander S.A.
Poland	Netherlands	Barclays Bank PLC
Russian Federation	Austria	BNP Parisbas
Brazil	Greece	Commerzbank A.
Chile	Portugal	Credit Agricole SA
Colombia	Italy	Credut Suisse Group Ltd
Peru	United Kingdom	Deutsche Bank A.
United Mexican States	Finland	Hannover Rueck AG
Abu Dhabi		HSBC Bank PLC
Dubai		Intesa San Paolo SPA
South Africa		LLOYDS TSB Bank PLC
Israel		Muenchener Rueck
Qatar		Societe Generale
United Stated of America		Swiss Reinsurance Company Ltd
		The Royal Bank of Scotland Plc
		UBS AG
		Unicredit SPA
		Zurich Insurance Company Ltd

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